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Rapides Parish, Louisiana

National Eutrophication Survey, Las Vegas, Nev

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Environmental Monitoring and Support Lab, Las Vegas, Nev

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NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES





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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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ON

COCODRIE LAKE

RAPIDES PARISH

LOUISIANA

EPA REGION VI

WORKING PAPER NO. 535

WITH THE COOPERATION OF THE

LOUISIANA WILD LIFE AND FISHERIES COMMISSION

AND THE

LOUISIANA NATIONAL GUARD

MARCH, 1977

REPORT ON COCODRIE LAKE

RAPIDES PARISH, LOUISIANA

EPA REGION VI

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 535

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

March 1977

CONTENTS

	Page
Forword	ii
List of Louisiana Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	4
III. Lake Water Quality Summary	6
IV. Nutrient Loadings	10
V. Literature Reviewed	15
VI. Appendices	16

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Louisiana Wild Life and Fisheries Commission, Division of Water Pollution Control for professional involvement, to the Louisiana National Guard for conducting the tributary sampling phase of the Survey, and to those Louisiana wastewater treatment plant operators who provided effluent samples and flow data.

Robert A. Lafleur, Chief; J. Dale Givens, Assistant Chief; Lewis B. Still, Biologist; Louis Johnson, Biologist; Lee Caubarreaux, Biologist; Darrell Reed, Engineer; Dempsey Alford, Biologist; and Elwood Goodwin, Water Quality Control Technician, all of the Louisiana Wild Life and Fisheries Commission, Division of Water Pollution Control reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

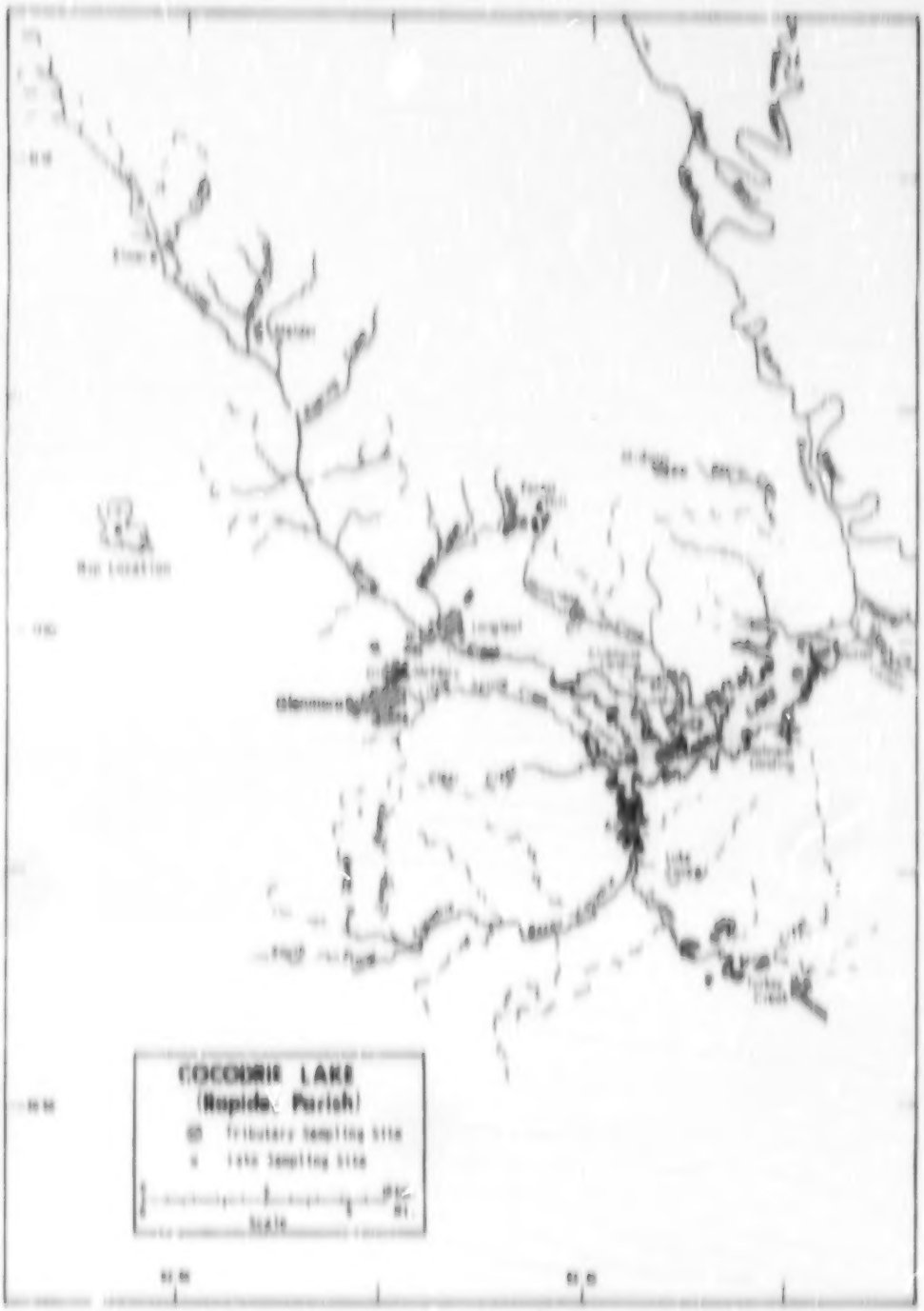
Major General O'Neil Datgle, Jr., the Adjutant General of Louisiana, and Project Officer Colonel Lawrence P. Dupre, who directed the volunteer efforts of the Louisiana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF LOUISIANA

LAKE NAME	PARISH
Anacoco Lake	Vernon
Lake Bistineau	Bienville, Webster
Black Bayou	Caddo
Black Lake	Natchitoches and Red River
Bruin Lake	Tensas
Bundick Lake	Beauregard
Caddo Lake	Caddo (Menon and Harrison in Texas)
Cocodrie Lake	Concordia
Cocodrie Lake (Lower)	Rapides
Concordia Lake	Concordia
Cottie Lake	Rapides
Cross Lake	Caddo
D'Arbonne Lake	Union
False River Lake	Pointe Coupee
Indian Creek Reservoir	Rapides
Saline Lake	LaSalle
Turkey Creek Lake	Franklin
Lake Vernon	Vernon
Lake Verret	Assumption


COCODRIE LAKE
(Rapides Parish)
Tributary Sampling Site
Lake Sampling Site
Scale

REPORT ON COCODRIE LAKE, LOUISIANA
STORET NO. 2220

I. CONCLUSIONS

A. Trophic Condition:*

On the basis of field observations and Survey data Cocodrie Lake is considered eutrophic, i.e., nutrient rich and highly productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses.

Chlorophyll a levels in the lake were very high, ranging from 12.3 ug/l to 53.8 ug/l with a mean of 33.4 ug/l. Of the 19 Louisiana lakes sampled in 1974, 4 had greater median total phosphorus, 8 had greater median dissolved orthophosphorus and 18 had greater median inorganic nitrogen than Cocodrie Lake.

Survey limnologists noted abundant aquatic plants at Station 01 during March sampling. Ketelle and Uttormark (1971) reported that the lake had problems with silt pollution due to runoff from past gravel dredging operations.

*See Appendix E.

B. Rate-Limiting Nutrient:

Mean inorganic nitrogen to orthophosphorus ratios (N/P) for Cocodrie Lake were 13/1 or less on both sampling occasions suggesting primary limitation by nitrogen. Algal assay results show high potential for primary production in the reservoir, and support nitrogen limitation.

C. Nutrient Controllability:

1. Point sources -

There were no known point sources impacting Cocodrie Lake during the sampling year. The mean annual phosphorus loading of 0.60 g $P/m^2/yr$ was less than the "oligotrophic" level proposed by Vollenweider (1975) for a lake with such volume and retention time. However, the calculated loading for Cocodrie Lake is somewhat underestimated. The nutrient concentrations in Little Spring Creek were substantially higher than those of any other sampled tributary entering the lake (Section IV-E). Since Little Spring Creek was not gaged, and is included in the estimated ungaged nutrient loading to the lake (based upon background loading from other gaged tributaries), it is likely that the true nutrient loads to Cocodrie Lake are much higher than indicated herein. Additional sampling is needed to determine an accurate nutrient budget for the lake.

f. Nonpoint sources -

The mean annual phosphorus loads from measured tributaries amounted to 62.0% of the total load reaching Cocodrie Lake. Cocodrie Bayou contributed 45.3% of the total nonpoint load, and ungaged tributaries were estimated to have contributed 34.9%.

In general, few lakes are nitrogen limited as a result of low nitrogen. Rather, excessive phosphorus levels shift limitations to nitrogen or other factors. Regardless of the primary nutrient limitation suggested by either algal assay or nutrient ratios, the most feasible approach to nutrient control, if desirable, is through available phosphorus control technology and subsequent establishment of phosphorus limitation within the water body.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake morphometry values were provided by the State of Louisiana. Tributary flow data were provided by the Louisiana District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by the mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 24.68 km^2.
2. Mean depth: 0.5 meters.
3. Maximum depth: 4.3 meters.
4. Volume: 13.569 x 10^6 m^3.
5. Mean hydraulic retention time: 14 days.

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage Area (km^2)	Mean Flow (m^3/sec)
A-2 Cocodrie Bayou	186.7	2.55
B-1 Spring Creek	177.7	2.44
Minor tributaries and immediate drainage -	205.0	4.66
Totals	569.4	9.66
2. Outlet - A-1 Cocodrie Bayou	621.4	11.84

C. Precipitation:

1. Year of sampling: 176.2 cm.
2. Mean annual: 155.4 cm.

III. LAKE WATER QUALITY SUMMARY

Cocodrie Lake was sampled two times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake (Station 02 was sampled only once) and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the last visit, an 18.9-liter depth-integrated sample was composited for algal assays. Maximum depths sampled were 2.4 meters at Station 01 and 2.4 meters at Station 02. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera		Algal Units per ml
05/29/74	1.	Flagellates	1,592
	2.	Dactylococcopsis	1,493
	3.	Synedra	1,393
	4.	Cryptomonas	1,294
	5.	Centric diatom	596
		Other genera	3,481
		Total	10,149
11/12/74	1.	Lyngbya	17,947
	2.	Dactylococcopsis	6,505
	3.	Nitzschia	4,075
	4.	Melosira	2,508
	5.	Microcystis	940
		Other genera	6,348
		Total	38,323

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
05/29/74	01	53.8
11/12/74	01	22.3
	02	24.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum yield (mg/l dry wt.)
Control	0.020	0.063	1.0
0.05 P	0.075	0.063	2.7
0.05 P + 1.0 N	0.073	1.063	23.0
1.00 N	0.026	1.063	11.4

2. Discussion -

The control yield of the assay algae, Selenastrum capricornutum, indicates that the potential for primary production in Cocodrie Lake was high at the time of autumn assay sample collection. Strong growth response to the addition of nitrogen, as well as the lack of significant response to the addition of phosphorus indicates nitrogen limitation. Maximum yield was achieved with the simultaneous addition of both nutrients.

Cocodrie Lake was not sampled in March 1974. Consequently, no spring algal assay sample was collected.

The N/P ratios for Cocodrie Lake were 13/1 in the summer and 2/1 during autumn, suggesting primary limitation by nitrogen (an N/P ratio of 14/1 or greater generally reflects phosphorus limitation). It should be noted that significant chemical changes took place in Louisiana lake samples between collection and algal assay. The assay data should be considered in this context and until such difficulties are resolved, used with caution for any prediction of actual lake conditions. Such chemical changes are likely to alter the control yield as well as modifying the N/P ratio.

IV. NUTRIENT LOADINGS
(See Appendix B for data)

For the determination of nutrient loadings, the Louisiana National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of February, March, and April when two samples were collected. Sampling was begun in June 1974, and was completed in May 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Louisiana District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage"("ZZ" of USGS) were estimated by using the mean annual of the nutrient loads, in $kg/km^2/yr$, in Cocodrie Bayou and Spring Creek at Stations A-2 and B-1, and multiplying the means by the ZZ area in km^2.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Cocodrie Bayou	6,635	45.2
B-1 Spring Creek	2,465	16.9
b. Minor tributaries and immediat- drainage (nonpoint load) -	5,125	34.9
c. Known municipal STP's - None		
d. Septic tanks* -	30	0.2
e. Known industrial - None		
f. Direct precipitation** -	430	2.9
Totals	14,685	100.0
2. Output - A-1 Cocodrie Bayou	13,075	
3. Net annual P accumulation	1,610	

*Estimate based on 100 lakeside residences.
**Estimated (see WES Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Cocodrie Bayou	64,040	35.5
B-1 Spring Creek	33,960	18.8
b. Minor tributaries and immediate drainage (nonpoint load) -	54,735	30.3
c. Known municipal STP's - None		
d. Septic tanks* -	1,065	0.6
e. Known industrial - None		
f. Direct precipitation** -	26,645	14.8
Totals	180,435	100.0
2. Output - A-1 Cocodrie Bayou	186,195	
3. Net annual N export*** -	5,760	

*Estimate based on 100 lakeside residences.
**Estimated (see NES Working Paper No. 175).
***Export probably due to unknown sources and/or sampling error.

H. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Cocodrie Bayou	36	343
Spring Creek	14	191

I. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
C-1 Hurricane Creek	0.061	0.430
D-1 Little Spring Creek	0.384	1.893

Nutrient concentrations in Hurricane Creek are in line with those found in the gaged tributaries entering Cocodrie Lake. However, nutrient concentrations in Little Spring Creek are substantially higher. This could be due to the proximity of the D-1 sampling site to the town of Glenmora, or to unknown point sources impacting the creek upstream.

F. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotrophic" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A "mesotrophic" loading would be considered one between "eutrophic" and "oligotrophic".

Note that Vollenweider's model may not apply to lakes with short hydraulic retention times or in which light penetration is severely restricted by high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading ($g/m^2/yr$)
Estimated loading for Cocodrie Lake	0.60
Vollenweider's "eutrophic" loading	1.54
Vollenweider's "oligotrophic" loading	0.77

V. LITERATURE REVIEWED

Ketelle, Martha J. and Paul O. Uttormark. 1971. Problem Lakes in the United States. U.S. Environmental Protection Agency Project #16010 EHR. University of Wisconsin, Madison, Wisc.

U.S. Environmental Protection Agency. 1978. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Vollenweider, R. A. 1975. Input-Output Models With Special Reference to the Phosphorus Loading Concept in Limnology. Schweiz. Z. Hydrol. 37:53-84.

VI. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B
TRIBUTARY FLOW DATA

APPENDIX C
PHYSICAL AND CHEMICAL DATA

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

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APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

STATE OF LOUISIANA

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